

**PET ARTIFICIAL AGGREGATE FOR THE PREPARATION OF
LIGHTENED CONCRETE**

The present invention provides a novel lightweight PET (polyethylenterephthalate) artificial aggregate for the production of lightened structural and non-structural concrete or materials for building industry, and a process for the preparation thereof.

5 **Background of the invention**

According to the UNI normative, light or lightened concrete has an apparent volume mass of from 200 to 2000 Kg/m³, that is, lower than that of conventional concrete (around 2400 Kg/m³). Important advantages are associated with the use of light concrete, for example, reduced weight and size
10 of building structures, reduced foundation-ground load, reduced seismic actions. Light or lightened concrete is prepared by replacing common aggregates with light aggregates, such as expanded clay, pearlite, vermiculite, rottenstone, lapilli, polystyrene. However, only few light aggregates are suitable for the production of structural concretes, i.e. concrete with compression cubic
15 resistance higher than 15 N/mm².

Description of the invention

It has now been found that a lightweight artificial aggregate consisting of PET granules provides structural and non structural concrete with properties of lightness, workability, mechanical resistance, durability and low
20 thermal conductivity.

The lightweight artificial aggregate according to the invention is composed of PET granules, which can be coated with fine or coarse sand to improve the adherence between grains and mortar.

In the preparation of the aggregate, PET material from different sources,
25 including recycled PET bottles, is reduced into flakes which are then subjected

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to a thermal and mechanical process thus forming a resistant, light aggregate. This aggregate, which will be referred to as "non-sanded" lightweight PET aggregate, can be used as such in the preparation of non-structural concrete. In alternative, the surface of the PET aggregate is covered or coated with sand, thus forming a "sanded" aggregate suitable for the manufacture of structural concrete.

In a preferred embodiment of the invention, sanded and non-sanded PET aggregates are produced as follows. A defined amount of PET flakes – depending on the desired granulometry and the volume mass of the granule – is placed in a ventilated oven and heated to a temperature of 250-260 °C for a time sufficient for flakes to curl and for their surface to soften, at the same time applying a vibratory and rotational mechanical movement to increase the number of contacts between flakes. When heating is ended, the aggregated flakes are subjected to a controlled pressure that gives them a spheroid shape. The applied compression strength determines the final resistance of the grain. It is important that during the process, PET does not reach complete melting. The thus produced non-sanded PET aggregate can be further processed to obtain a sanded aggregate. In this case, PET granules are subjected to surface flaming and rolled on fine or coarse sand to obtain uniform coating of the granules.

Sanded and non-sanded aggregates are separated by size with an appropriate sieve. The aggregates can have different sizes, ranging from 1 to 40 mm, which correspond to different resistance classes. Depending on the compression strength applied during granule formation, the number and size of the empty spaces within grains change and the mechanical resistance changes accordingly.

The aggregates are classified as i) fine, when the size does not exceed 3 mm, ii) medium, between 3 and 7 mm, and iii) coarse, over 7mm.

The heap weight of the PET aggregate depends on the granulometry and compression strength, but it is generally comprised between 100 and 1100 Kg/m³. By way of example, an aggregate in sanded PET with coarse size between 17 and 20 mm and subjected to low compression degree, has a heap weight of approximately 520 Kg/m³.

The lightweight artificial aggregate of the invention allows to prepare concrete with good mechanical resistance and a lower weight/volume ratio (<2000 Kg/m³) than conventional concrete. The concrete produced from PET aggregates possesses insulating properties due to the low thermal conductivity of PET. Examples of concrete/materials for building industry that can be produced from lightweight sanded-PET artificial aggregates include, but are not limited to, lightened structural concrete and concrete of the SCC type (Self-Compacting Concrete). Non-sanded aggregates are preferably used in the preparation of non-structural concrete as well as loose material for fillings with thermal and acoustic insulation properties, especially for aggregates with big grain size.

Since the aggregates can be produced from recycled materials, especially from recycled plastics such as PET bottles, their use in the preparation of concrete according to the present invention may provide an important contribution to waste disposal thus reducing the environmental impact of plastic wastes.

Description of the Figures

Fig. 1: granule of the artificial aggregate in "sanded PET"

Fig. 2: Coarse-size aggregate

Fig. 3: PET "flakes" used in the production of the artificial aggregate

Fig. 4: Curled flakes

Fig. 5: PET granules after forming

Tables**Lightweight structural concrete****Table 1. Properties of sanded lightweight PET aggregate**

Diameter (mm)	13 - 20
Heap weight (Kg/m ³)	520
Grain weight (Kg/m ³)	1316
Surface	sanded
Water absorption	negligible

5 The used formula is reported in table 2 showing that the most unfavourable condition has been chosen: a small quantity of concrete, a high ratio water/cement, a PET volume percentage equal to the 60% of the entire aggregate.

10 **Table 2. Mix Design of the structural concrete lightened with light artificial aggregate in "sanded" PET**

CEM I 42,5 R	285 Kg/m ³
Aggregate PET (13-20 mm)	557 Kg/m ³
Crusher sand	761 Kg/m ³
Water	170 l/m ³
Super-plasticizer	2,9 l/m ³
Ratio water/cement	0,6
Consistence	S5
Volume mass	1780 Kg/m ³
Compression resistance (28 dd)	27 Mpa

Lightweight aggregate of big grain size for fillings**Table 3. Properties of lightweight PET aggregate.**

Diameter (mm)	15 – 25
Heap weight (Kg/m ³)	400
Surface	not sanded
Water absorption	Negligible

The material is resistant, light, non conductive, invariable in time; it resists
5 distorsion also at high temperatures (not far from fusion point) and does not
go rotten. If burned, it does not emit toxic gases.